Acuvim–L Series Power Meter

User's Manual

Multifunction Power Meter

ACCUENERGY

The information contained in this document is believed to be accurate at the time of publication, however, Accuenergy assumes no responsibility for any errors which may appear here and reserves the right to make changes without notice. Please consult the local represent for latest product specifications before ordering.

Please read this manual carefully before installation, operation and maintenance of Acuvim-L power meter.

Following symbols used in this user's manual and on Acuvim-L power meter are to alert the danger or to prompt the operating or setting process.

Dangerous symbol, Failure to observe the information may result in injury or death.

Alert symbol, Alert the potential danger.
Observe the information after the symbol to avoid possible injury or death.

This mark is on product for UL Listed product

Installation and maintenance of the Acuvim-L power meter should only be performed by qualified, competent personnel that have appropriate training and experience with high voltage and current device.

Content

Starting!

Congratulations!

You have gotten an advanced, versatile and multifunction power meter. You may call it a Remote terminal unit (RTU). Your power system will benefit a lot from this multifunction power meter. Open the package, you will find the following items:

1.Acuvim-L power meter	1
2.Terminal	3 (2 for basic model)
3.Installation clips	4
4.Installation manual	1
5.maintenance guarantee card	1

Please read the manual carefully before operate and set the Acuvim-L power meter. You can read part of the manual depends on how you use the Acuvim-L power meter.

Chapter 1 helps you understand the fundamental function, specification and application of Acuvim-L.
Chapter 2 describes installation and connection of Acuvim-L.
Chapter 3 tells you the data display and parameter setting method of Acuvim-L.
Chapter 4 gives the address table of Acuvim-L.
Appendix lists the technical data and specifications of Acuvim-L and ordering information.

Chapter 1 Introduction

Characteristics of Acuvim-L

Application fields

Acuvim-L Series

1.1 Characteristics of Acuvim-L

Multifunction, high accuracy

Acuvim-L series multifunction power meter is designed using latest microprocessor and digital signal process technology. It can measure voltage, current, active power, reactive power, power factor for three phases, and also the apparent power, harmonic content up to 15^{th} ,THD, real and reactive energy, demand current and power, max/min values for real time readings. Expanded digital output and RS-485 communication interface perform the functions of energy pulse output, event alarm, remote data collection and control etc. You can read the measuring data even in dim environment easily with large and high clarity LCD screen. Except for strong function, Acuvim-L can also save you money.

Small size, easy installation

The installation dimension is according to IEC DIN (96×96mm square) and ANSI C39.1 (4 inch round) standard, the installation thickness is only 51mm, Acuvim-L power meter can be installed in a small cabin. And also with the self-fasten design, the Acuvim-L meter can be easily installed and removed without fasten bolt.

Easy to use

Acuvim-L has large screen, high clarity LCD and bright backlight, so you can read the data very easy even in dim environment. All the readings and setting parameters can be accessed by using the panel keys or communication port. The setting parameters are stored in EEPROM which can maintain its content even if the power of Acuvim-L shut off.

Flexible wiring connection

Whether in high or low voltage system; whether in 3-phase 3-wire, 3-phases 4-wire or single-phase system, Acuvim-L is easily to use.

1.2 Application fields

Acuvim-L series can work as Remote Terminal Unit (RTU) for collecting remote data and controlling in SCADA system, and also can work as multifunction power meter for monitoring and measuring in power distribution automation system. Acuvim-L adopts real RMS measure method and digital signal process technology so that it's especially fit for serious environment with nonlinear load. The main application fields are:

Power Distribution Automation	Intelligent Electric Switch Gear
Industry Automaton	Building Automation
Energy Manage System	Large UPS system

1.3 Acuvim-L series

The Acuvim-L series have three kinds of products. They are Acuvim-AL (basic model), Acuvim-BL (basic model+2do) and Acuvim-CL (basic model+RS485). All functions shows in table 1-1.

Table 1-1 Functions of Acuvim-L series

Function		Parameters	AL	BL	CL
Real time Measuring	Phase voltage	U1, U2, U3	●	●	●
	Line voltage	U12, U23, U31	●	●	●
	Current	I1, I2, I3, In	●	●	●
	Power	P1, P2, P3, Psum	●	●	●

Real time Measuring	Reactive Power	Q1，Q2，Q3，Qsum	●	●	●
	Apparent Power	Ssum	●	●	●
	Power Factor	PF1，PF2，PF3，PF	●	●	●
	Load Character	L/C/R	●	●	●
Energy & demand	Real Energy	Ep_imp, Ep_exp,	●	●	●
	Reactive Energy	Eq_imp, Eq_exp,	●	●	●
	Current Demand	Dmd_I1,Dmd_I2 Dmd_I3	●	●	●
	Power Demand	Dmd_Psum, Dmd_Qsum	●	●	●
Power Quality	Voltage unbalance factor	U_unbl	●	●	●
	Current unbalance factor	I_unbl	●	●	●
	Voltage THD	THD_V1, THD_V2, THD_V3,	●	●	●
	Current THD	THD_I1, THD_I2, THD_I3,	●	●	●
	Voltage Harmonics	2nd to 15st	●	●	●
	Current Harmonics	2nd to 15st	●	●	●
Statistics	Peak power demand	Dmd_I1_max,Dmd_I2 _max,Dmd_I3_max	●	●	●
	Peak current demand	Dmd_Psum_max, Dmd_Qsum_max	●	●	●
	Max/Min voltage		●	●	●
	Max/Min Current		●	●	●
Time	Running Time	Hour	●	●	●
I/O	Pulse output			●	
	Alarm output			●	
Communication	RS-485	MODBUS™ Protocol			●

Note: ● Possessed functions

Chapter 2 Installation

Appearance and Dimesions

Installation method

Wiring of Acuvim-L

Considerations When Installing Meters

- Installation of the Meter must be performed by only qualified personnel who follow standard safety precautions during all procedures. Those personnel should have appropriate training and experience with high voltage devices. Appropriate safety gloves, safety glasses and protective clothing are recommended.
- During normal operation of the Meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces.
- Do not use the meter or any I/O Output Device for primary protection or in an energy-limiting capacity. The meter can only be used as secondary protection. Do not use the meter for applications where failure of the meter may cause harm or death. Do not use the meter for any application where there may be a risk of fire.
- All meter terminals should be inaccessible after installation.
- Do not apply more than the maximum voltage the meter or any attached device can withstand. Refer to meter and/or device labels and to the Specifications for all devices before applying voltages. Do not HIPOT/ Dielectric test any Outputs, Inputs or Communications terminals.
- ACCUENERGY recommends the use of Shorting Blocks and Fuses for voltage leads and power supply to prevent hazardous voltage conditions or damage to CTs, if the meter needs to be removed from service. CT grounding is optional.
- ACCUENERGY recommends use dry cloth to wipe the meter.

NOTE: IF THE EQUIPMENT IS USED IN A MANNER NOT SPECIFIED BY THE MANUFACTURER, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED.

NOTE: THERE IS NO REQUIRED PREVENTIVE MAINTENANCE OR INSPECTION NECESSARY FOR SAFETY. HOWEVER, ANY REPAIR OR MAINTENANCE SHOULD BE PERFORMED BY THE FACTORY.

DISCONNECT DEVICE: The following part is considered the equipment disconnect device.

A SWITCH OR CIRCUIT-BREAKER SHALL BE INCLUDED IN THE END-USE EQUIPMENT OR BUILDING INSTALLATION. THE SWITCH SHALL BE IN CLOSE PROXIMITY TO THE EQUIPMENT AND WITHIN EASY REACH OF THE OPERATOR. THE SWITCH SHALL BE MARKED AS THE DISCONNECTING DEVICE FOR THE EQUIPMENT.

This chapter tells you how to install Acuvim-L power meter. Please read this chapter carefully before your installation.

2.1 Appearance and Dimensions of Acuvim-L

Appearance

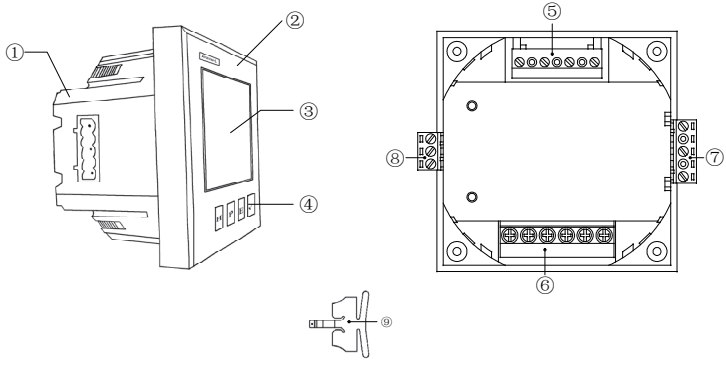
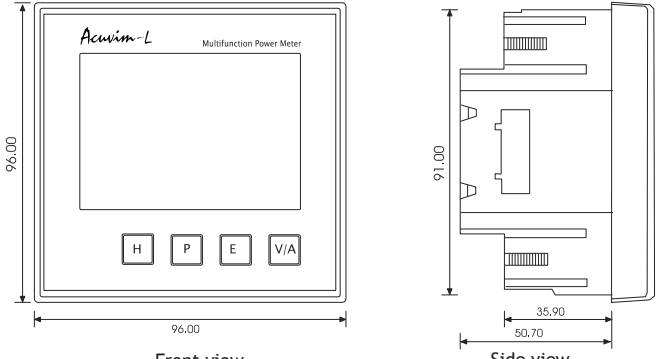


Figure.2-1 Appearance of Acuvim-L

Parts	Description
① Enclosure	Made of high strength anti-combustion engineering plastic
② Front casing	Revealed out of Panel
③ LCD display	Large bright LCD display
④ key	Select what to be displayed and set Parameter
⑤ Voltage input terminals	Voltage inputs
⑥ Current input terminals	Current inputs
⑦ Power input terminals	Power supply inputs
⑧ RS-485 or digital output terminals	RS-485 port is used to communication; digital output port is used for pulse output or alarm output.
⑨ Installation clips	Used to fix the power meter

Table 2-1 Parts of Acuvim-L

Dimensions (mm)



Front view Side view

Fig.2-2 Dimensions of Acuvim-L

2.2 Installation of Acuvim-L

> **Note**
>
> Temperature and humidity of the environment must accord with the requirement of acuvim-L, Otherwise it may cause the meter damaged.

Environment

Please check the environmental temperature and humidity according to Acuvim-L's requirement to ensure the power meter can work well.

1.Temperature

Operation: -20℃ to 70℃ Storage: -40℃ to 85℃

2.Humidity

5% to 95% No condensation

3、Location

Acuvim-L power meter should be installed in dry environment with no dust and kept away from heat, radiation and high electrical noise source.

Installation steps

Normally, Acuvim-L is installed on the panel of the switch gear.

1、firstly, cut a square or round hole which according to the standard of DIN or ANSI on the panel of the switch gear. The cutting size shows as Fig.2-3.

unit (mm)

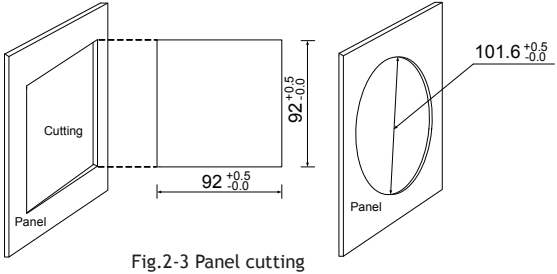


Fig.2-3 Panel cutting

2、secondly, remove the clips from the meter and put Acuvim-L into the square hole from the front side.

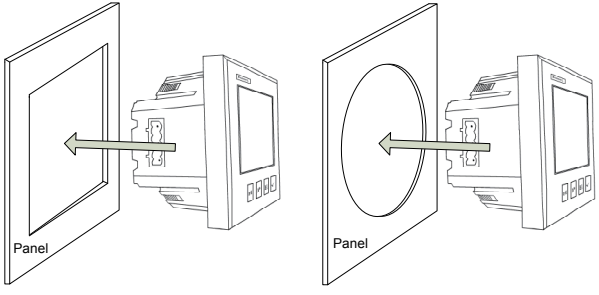


Fig.2-4 Put the meter into the square

3、Finally, put the clips to the meter from backside and push the clip tightly so that the meter is fixed on the panel.

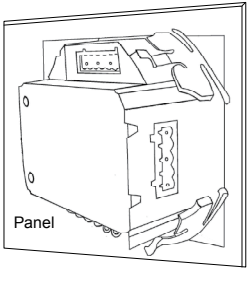
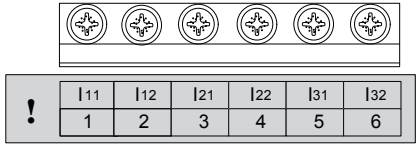


Fig.2-5 Use clips to fix the meter

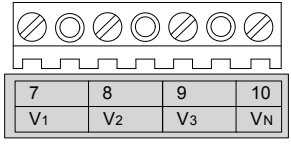
2.3 Wiring connection of Acuvim-L

There are four or three terminal strips on the back of Acuvim-L according to different model. They are voltage input terminal strips, current input terminal strips, DO output terminal strips or communication terminal strips and power supply terminal strips. The 1, 2 and 3 are used to represent each phase of three phase system. They have the same meaning as A, B and C or T, S and T in three phase system.

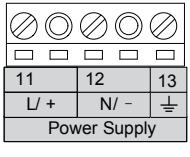
Current input terminal strips



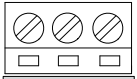
Voltage input terminal strips



Power supply terminal strips

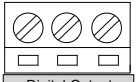


Communication terminal strips



Comm Port		
A	B	S
14	15	16

Digital output terminal strips



Digital Output		
DO 1	DO 2	DOC
14	15	16

Fig.2-6 Terminal diagram of Acuvim-L

Note:

Model Acuvim-AL has no digital output and communication terminal strips, Model Acuvim-BL has digital output terminal strips only and Acuvim-CL has communication terminal strips only.

Danger

Only the qualified personnel could do the wire connection work. Make sure that the power supply is cut off and all the wires are powerless. Failure to observe it may result in severe injury or death.

Safety Earth Connection

Before doing the meter wiring connection, please make sure that the switch gear has a safety Earth system. Connect the meter safety earth terminal to the switch gear safety earth system. The following safety earth symbol is used in this user's manual.

Fig.2-7 Earth ground symbol

Note

Make sure the voltage of power supply is the same as what the meter needed for its auxiliary power.

Auxiliary power

The auxiliary power supply of the Acuvim-L is 100~415Vac (50/60Hz) or 100V~300Vdc. Typical power consumption of the meter is less than 2W. A regulator or a UPS should be used when the power supply undulates too much.

The terminals for the auxiliary power supply are 11, 12 , 13 (L, N, ⏚).

The typical wiring connection is shown as Fig.2-8.

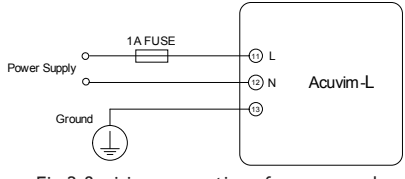


Fig.2-8 wiring connection of power supply

The wire of power supply could be AWG22-16 or 0.6-1.3mm^2. A fuse (typical 1A/250Vac) should be used in auxiliary power supply loop. No.13 terminal must be connected to the safety earth system of switchgear. An isolated transformer or EMC filter should be used in the auxiliary power supply loop if there is power quality problem in the power supply.

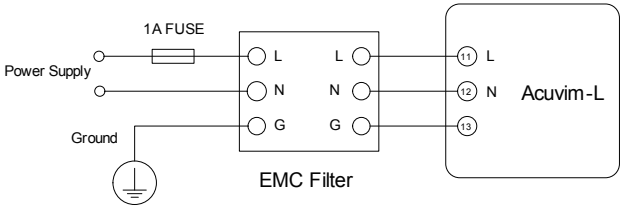


Fig.2-9 wiring connection of auxiliary power supply w ith EMC filters

Voltage input

Input Voltage of Acuvim-L should be 40~400Vac L-N, 70~690Vac L-L. The meter is suitable for low voltage or high or medium voltage system three phase system which voltage or secondary of PT lower than this range.

Note

The secondary of PT can not be shorted; otherwise it may cause the severe damage of the instrument.

A fuse (typical 1A) should be used in voltage input loop. PT should be used to transform the high voltage into measurement range of Acuvim-L if it is used in high voltage system. The wire number of voltage input could be AWG16-12 or 1.3-2.0mm^2.

Note: In no circumstance could the secondary of PT be shorted. The secondary of PT, should be well grounded at one end.

Current input

In a practical engineering application, CTs should be installed in the loop of measuring. Normally the secondary of CT is 5A. 1A is possible in the ordering option. A CT of accuracy over 0.5% (rating over 3VA) is recommended and it will influence the measuring accuracy. The wire between CT and Acuvim-L should be as shorter as possible. The length of the wire may increase the error of the measurement. CTs must be required if the rated current over 5A.

The wire number of current input could be AWG15-10 or 1.5-2.5mm^2.

Note: The CT loop should not be open circuit in any circumstance when the power is on. There should not be any fuse or switch in the CT loop and one end of the CT loop should be well connected to the ground.

Vn connection

Vn is the reference point of Acuvim-L voltage input. The lower is the wire resistance the less is the error.

Three phase wiring diagram

Acuvim-L can satisfy almost all kinds of three phase wiring diagram. Please read this part carefully before you begin to do the wiring so that you may chose a wiring diagram suitable for your power system.

The voltage and current input wiring mode can be set separately in the meter parameter setting process. The voltage wiring mode could be 3-phase 4-line Wye (3LN), 3-phase 4-line 2PT Wye mode (2LN), 3-phase 3-line open delta (2LL) and 3-phase 3-line direct connection mode (3LL). The current input wiring mode could be 3CT, 2CT and 1CT. Any voltage mode could be group with one of the current mode.

Voltage Input Wiring

3-Phase 4-Line Wye mode (3LN)

The 3-Phase 4-Line Wye mode is popularly used in low voltage electric distribution power system. The power line can be connected to the meter voltage input directly as in fig.2-10a. In the high voltage input system, 3PT Wye mode is often used as in fig.2-10b. The voltage input mode of the Acuvim-L should be set 3LN for both voltage input wiring mode.

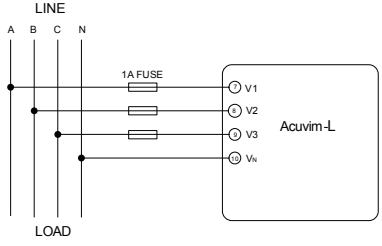


Fig.2-10a 3Ln direct connection

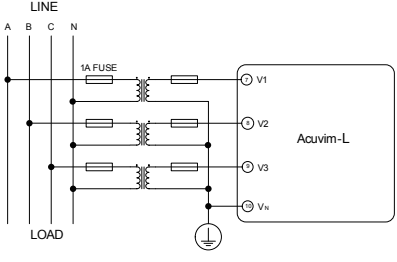


Fig.2-10b 3Ln connection with 3PTs

3-Phase 4-Line 2PT mode (2LN)

In some 3-Phase 4-Line Wye system, 2PT Wye mode is often used as in Fig.2-11. It is supposed that the 3 phases of power system are balanceable. The voltage of V2 is calculated according to the V1 and V3. The voltage input mode of the Acuvim-L should be set 2LN for 2PT voltage input wiring mode.

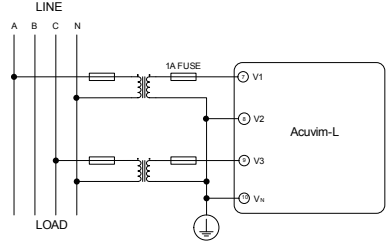


Fig.2-11 2Ln connection with 2PTs

3-Phase 3-Line direct connection mode (3LL)

In a 3-Phase 3-Line system, power line A, B and C are connected to V1, V2 and V3 directly. Vn is floated. The voltage input mode of the Acuvim-L should be set 3LL.

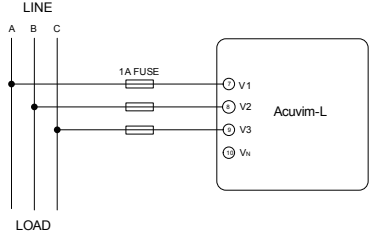


Fig.2-12 3LL 3-phase 3-line direct connection

3-Phase 3-Line open Delta Mode (2LL)

Open delta wiring mode is often used in high voltage system. V2 and Vn connected together in this mode. The voltage input mode of the Acuvim-L should be set 2LL for voltage input wiring mode.

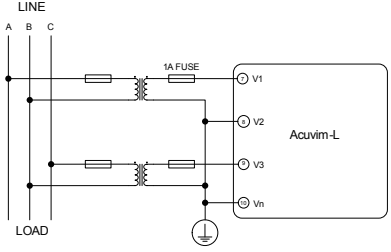


Fig.2-13 2LL with 2PTs

Current Input Wiring

3CT

All the current input of three phase system can be looked as 3CT one, whether there are 2 CTs or 3 CTs in the input side. The current input mode of the Acuvim-L should be set 3CT for this current input wiring mode.

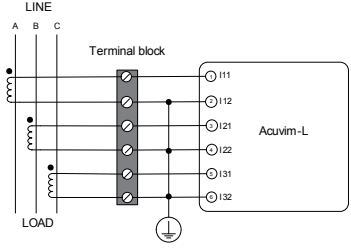


Fig.2-14 3CT-a

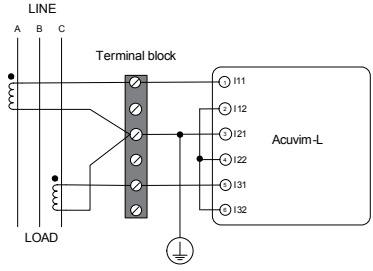


Fig.2-15 3CT-b

2CT

The difference of the fig.2-16 and the fig.2-15 is that there is no current input in the I21 and I22 terminals. The I2 value is calculated from formula i1+i2+i3=0. The current input mode of the Acuvim-L should be set 2CT for this current input wiring mode.

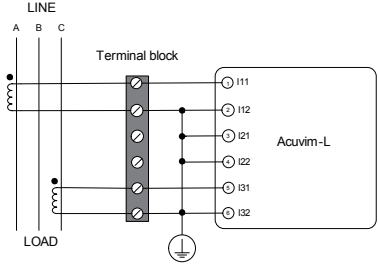


Fig.2-16 2CT

1CT

If it is a three phase balance system, 1 CT connection method can be

used. All the other two current are calculated according to the balance supposing.

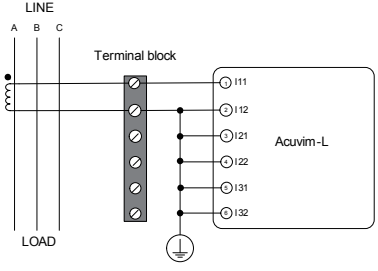


Fig.2-17 1CT

Frequently used wiring method

The voltage and current wiring method are put together in one drawing. The Acuvim-L meter will display normally only that the setting of the meter is assorted with the wiring of the voltage and current input.

1. 3LN, 3CT with 3 CTs (Wiring mode: 3Ln, 3CT)

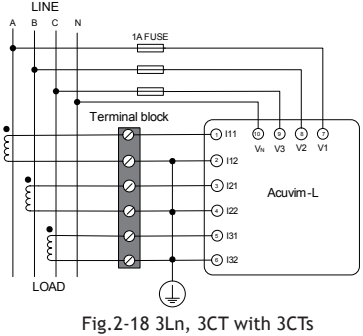


Fig.2-18 3Ln, 3CT with 3CTs

2. 3LN, 3CT with 2 CTs (Wiring mode: 3Ln,3CT)

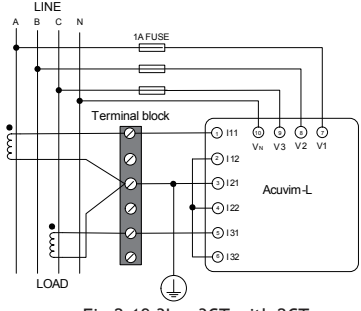


Fig.2-19 3Ln, 3CT with 2CTs

3. 2LN, 2CT (Wiring mode: 2Ln, 2CT)

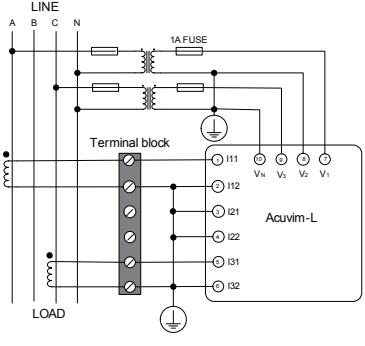


Fig.2-20 2Ln, 2CT

4. 2LN, 1CT (Wiring mode: 2Ln, 1CT)

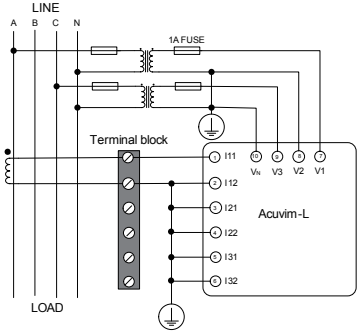


Fig.2-21 2Ln, 1CT

5. 2LL, 3CT (Wiring mode: 2LL, 3CT)

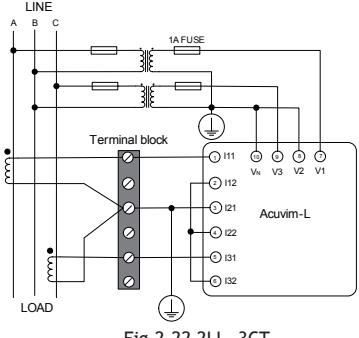


Fig.2-22 2LL, 3CT

6. 2LL, 2CT (Wiring mode: 2LL, 2CT)

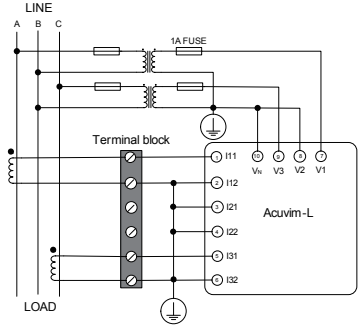


Fig.2-23 2LL, 2CT

7. 2LL, 1CT (Wiring mode: 2LL, 1CT)

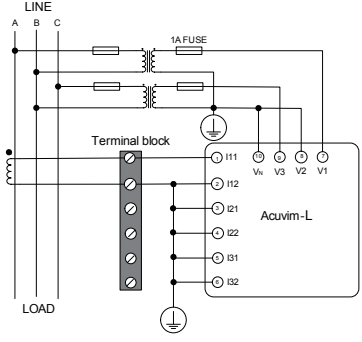


Fig.2-24 2LL, 1CT

8. Single Phase 2 Line (wiring mode: 3LN, 3CT)

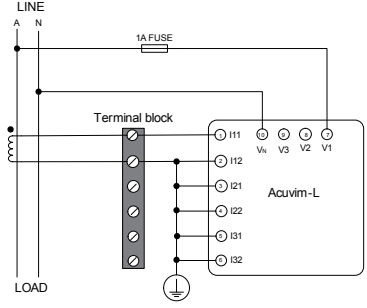


Fig.2-25 Single Phase 2 Lines

9. Single Phase 3 Line (Wiring mode: 3LN, 3CT)

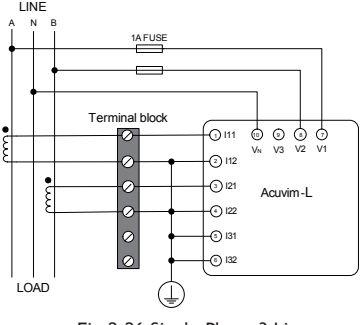


Fig.2-26 Single Phase 3 Lines

Digital output (DO)

There are two digital outputs for Acuvim-BL. The terminals of the digital output are DO1, DO2 (14, 15) and DOC (16). These two digital outputs can be used as energy pulse output or over limit alarming output.

Digital output circuit form is Photo-MOS. The simplified circuit is as below:

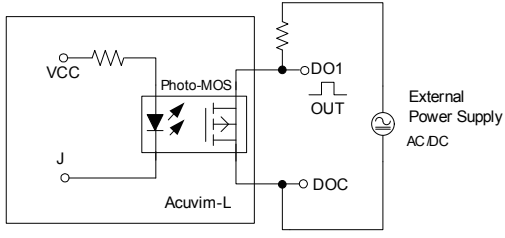


Fig.2-27 Digital output circuit

The Max output voltage and current are 250Vac/300Vdc and 50mA.

When the digital output is used as over limit alarm output, the up and low limit of the parameter, time interval and output port can be set.

Communication

The communication port and protocol of Acuvim-L are RS485 and Modbus-RTU. The terminals of communication are A, B, and S (14, 15 and 16). A is differential signal +, B is differential signal - and S is connected to shield of twisted pair cable. Up to 32 devices can be connected on a RS485 bus. Use good quality shielded twisted pair cable, AWG22 (0.5mm^2) or larger. The overall length of the RS485 cable connecting all devices can not exceed 1200m (4000ft). Acuvim-L is used as a slave device of master like PC, PLC, data collector or RTU.

If the master does not have RS485 communication port, a converter has to be used. Normally a RS232/RS485 or USB/RS485 is adopted. The topology of RS485 net can be line, circle and star.

The recommendations for the high quality communication, Good quality shielded twisted pair of cable AWG22 (0.6mm^2) or larger is very important.

The shield of each segment of the RS485 cable must be connected to the ground at one end only.

Keep communication cables away as much as possible from sources of electrical noise.

Use RS232/RS485 or USB/RS485 converter with optical isolated output and surge protection.

Chapter 3 Meter Operation and Parameter Setting

Display panel and keys

Metering data reading

Statistics display

Meter Parameter Setting

Introduction of measurement and functions

Detail human-machine of the meter will be described in this chapter. This includes how to get the metering data and set the parameter of the meter.

3.1 Display panel and keys

There are one display panel and four keys in front of Acuvim-L. All display segments are shown as Fig.3-1 below:

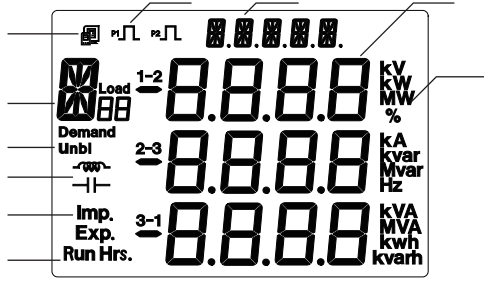


Fig.3-1 All display segments

SN	display	Description
1	Three lines of "8 "letter in the metering area	Display metering data Voltage, current, power, power factor, THD, frequency, demand, unbalance factor, max, min etc.
2	Status display area One line "8 " letter at the top of display panel	Display currant status Meter: metering status; Max: maximum value; Min: minimum value; THD: display THD: Har: display data is harmonic.
3	Item label 	Item label U: voltage. I: Current, P: active power; q: reactive power; PF: power factor; when display harmonic rate, the little 8 letter displays harmonic number.
4	3-phase unbalance Unbl	Unbalance label
5	Load nature	Capacitor label: capacitive load; Inductor label: inductive load.
6	Energy label Imp. Exp.	Imp: consumption energy; exp: generating energy
7	Communication indicator 	No label: no communication With label: communication
8	Energy pulse output indicator 	No label: no pulse output With label: pulse output
9	Time label Run Hrs.	With label: display running time
10	Unit	Indicate data unit Voltage: V, kV, Current: kA, A, Power: kW and MW, Reactive Power: kvar and Mvar, Apparent Power: kVA and MVA, Frequency: Hz, Energy: kWh, Reactive Power: kvarh, Percentage: %

There are four delicate keys in the front panel, labeled as H, P, E and V/A from left to right. Use these four keys to read metering data and set the parameters.

3.2 Metering data reading

Normally, Acuvim-L displays the metering data, such as voltage, current, power etc. There are several key patterns: press key “H”, press key “P”, press key “E”, and press key “V/A”, press key “H” and key E simultaneously.

Press “V/A” to read voltage and current in the metering area. The screen will roll to the next display as you press “V/A” each time. It will go back to the first screen if you press “V/A” at the last screen.

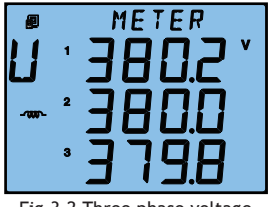


Fig.3-2 Three phase voltage

The 1st screen: display U1, U2 and U3 as Fig.3-2: U1=380.2V, U2=380.0V, U3=379.8V.

Load nature is inductive, and communication is normal.

Note: load nature and communication status is system information, they will display in every screen.

Press V/A, go to next screen.

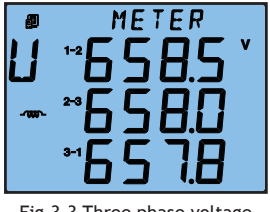


Fig.3-3 Three phase voltage

The 2nd screen: display voltage of line to line as shown in Fig.3-3:

U12=658.5V, U23=658.0, U31=657.8.

Press “V/A, go to the next screen.

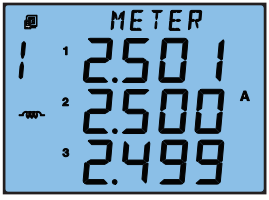


Fig.3-4 Three phase current

The 3rd screen: display current of each phase I1, I2 and I3 shown as Fig.3-4:
I1=2.501A I2=2.500A, I3=2.499A.

Press “V/A”, go to the next screen.

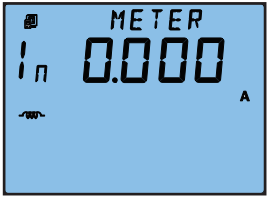


Fig.3-5 Neutral current

The 4th screen: display neutral current.
As in Fig.3-5, In=0.000A.

Press “V/A”, go to the next screen.

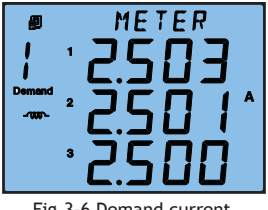


Fig.3-6 Demand current

The 5th screen: display current demand of each phase.
As in Fig.3-6, Dmd_I1=2.503A, Dmd_I2=2.501A, Dmd_I3=2.500A.

Press “V/A”, go back to the 1st screen.

Note: when the voltage wiring of the meter is set to 2LL, there is no phase voltage and natural current screen, namely no 1st and 4th screen, only 2nd, 3rd and 5th screen.

Press “P” key, display metering readings related power.

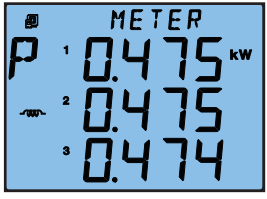


Fig.3-7 Three phase power

The 1st screen: display the power of each phase.

As in Fig.3-7, P1=0.475kW, P2=0.475kW, P3=0.474kW.

Inductive load, communication status is normal.

Press “P”, go to the next screen.

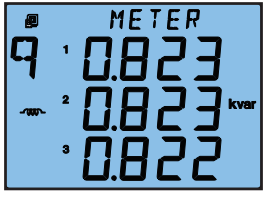


Fig.3-8 Three phase reactive

The 2nd screen: display the reactive power of each phase.

As in Fig.3-8, Q1=0.823kvar, Q2=0.823kvar

Q3=0.822kvar.

Press “P”, go to the next screen.

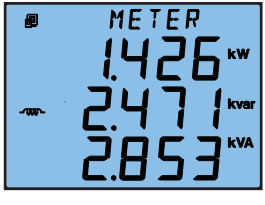


Fig.3-9 Power reactive and apparent power

The 3rd screen: display system total power, reactive power and apparent power.

As in Fig.3-9, Psum=1.426kW, Qsum=2.471kvar, Ssum=2.853kVA.

Press “P”, go to the next screen.

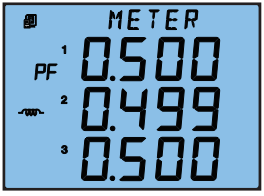


Fig.3-10 Three phase power factor

The 4th screen: display power factor of each phase PF1, PF2, PF3.

As in Fig.3-10, PF1=0.500, PF2=0.499, PF3=0.500.

Press “P”, go to the next screen.

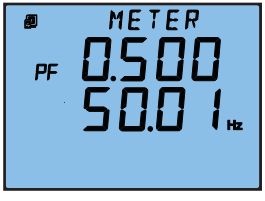


Fig.3-11 Power factor and frequency

The 5th screen: display system average power factor PF and system frequency F.

As in Fig.3-11, PF=0.500, F=50.01Hz.

Press “P”, go to the next screen.

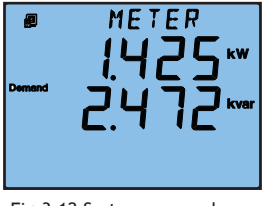


Fig.3-12 System power demand

The 6th screen: display system power demand Dmd_P and reactive power demand Dmd_Q.

As in Fig.3-12, Dmd_P=1.425kW, Dmd_Q=2.472kvar.

Press “P”; go back to the 1st screen.

Note: when the voltage wiring of the meter is set to 2LL or 3LL, there is no phase power, phase reactive power and phase power factor screen. Only the 3rd, 5th and 6th screen displayed.

Press “E” key: display energy and run time.

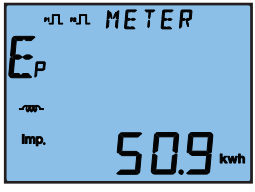


Fig.3-13 import energy

The 1st screen: display the consumption energy

Ep_imp=50.9kwh as in Fig.3-13.

Press “E”, go to the next screen.

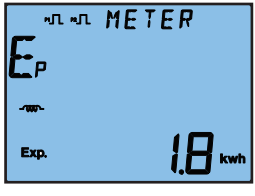


Fig.3-14 Export reactive energy

The 2nd screen: display the generation energy.

Ep_exp=1.8kwh as in Fig.3-14.

Press “E”, go to the next screen.

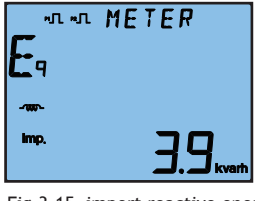


Fig.3-15 import reactive energy

The 3rd screen: display the inductive reactive energy.

Eq_imp=3.9kvarh as in Fig.3-15.

Press “E”, go to the next screen.

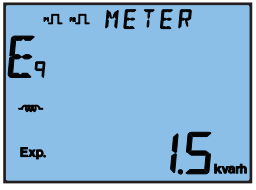


Fig.3-16 Export reactive energy

The 4th screen: display the capacitive reactive energy.

Eq_exp=1.5kvarh as in Fig.3-16.

Press “E”, go to the next screen.

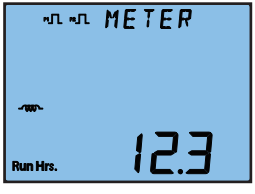


Fig.3-17 Run time

The 5th screen: display the run time.

As in Fig.3-17, Run_Hour=12.3 hours.

Press “E”, go back to the 1st screen.

Press “H” key, display data of power quality.

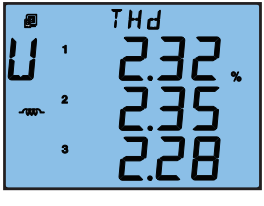


Fig.3-18 Voltage THD of phase

The 1st screen: display THD of voltage.

The display will be THD of line to line voltage THD_U12, THD_U23, THD_U31 when the wiring of voltage input is 2LL or 3LL. The display will be THD of phase voltage THD_U1, THD_U2, THD_U3 when the wring of the voltage input is 2LN or 3LN.

As in Fig. 3-18, THD_U1=2.32%, THD_U2=2.35%, THD_U3=2.28%.

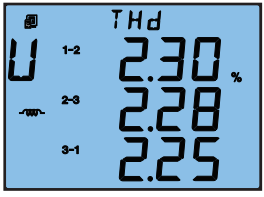


Fig.3-19 Voltage THD of line to line

When the wiring of the voltage is set to be "2LL or 3LL, the display will be THD of line to line voltage.

As in Fig.3-19, THD_U12=2.30%, THD_U23=2.28%, THD_U31=2.25%.

Press "H" key, go to the next screen.

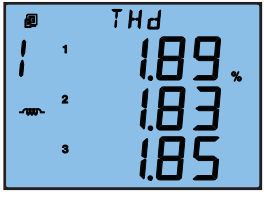


Fig.3-20 Current THD

The 2nd screen: display THD of phase current THD_I1, THD_I2, THD_I3.

As in fig 3.20, THD of three phase current, THD_I1=1.89%, THD_I2=1.83%, THD_I3=1.85%.

Press "H" key; go back to the 1st screen.

3.3 Statistics Display

Press the "E" and "H" Keys simultaneously, the Max and Min value of metering data, three phase voltage and current unbalance factor and harmonic rate will display on the screen.

Press the "E" and "H" Keys simultaneously, go to the statistics screen.

3.3.1 Display Max and Min of the voltage and current and peak value of current demand.

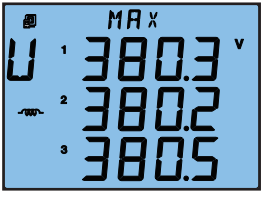


Fig.3-21 Max value of phase voltage

The 1st screen: Display the Max value of voltage. The Max label display on the top of screen.

As in Fig. 3-21, U1_max=380.3V, U2_max=380.2V, U3_max=380.5V.

Press "V/A" key under the statistics display mode, to display the Min and Max value of voltage, current and current demand.

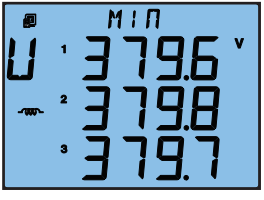


Fig.3-22 Min value of phase voltage

The 2nd screen: display the Min value of voltage. The Min label display on the top of screen.

As in Fig.3-22 ,U1_Min=379.6V, U2_Min =379.8V, U3_Min=379.7V.

Press "V/A", go to the next screen.

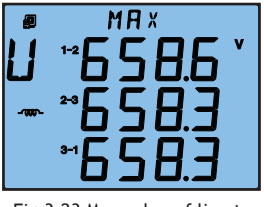


Fig.3-23 Max value of line to line voltage

The 3rd screen: display the Max value of line to line voltage.

As in fig 3.23 U12_Max=658.6V, U23_Max=658.3V, U31_Max=658.3V.

Press "V/A", go to the next screen.

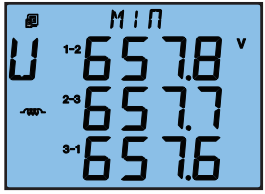


Fig.3-24 Min value of line to line voltage

The 4th screen: display the Min value of line to line voltage.

As in Fig.3-24 U12_Min=657.8V, U23_Min=657.7V, U31_Max=657.6V.

Press “V/A”, go to the next screen.

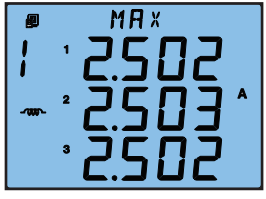


Fig.3-25 Max value of current

The 5th screen: display the Max value of current.

As in Fig.3-25 I1_Max=2.502A, I2_Max=2.503A, I3_Max=2.502A.

Press “V/A”, go to the next screen.

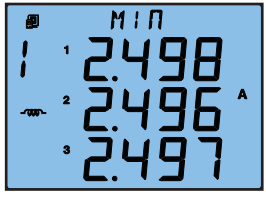


Fig.3-26 Min value of current

The 6th screen: display the Min value of current.

As in fig.3-26 I1_Min=2.498A, I2_Min=2.496A, I3_Min=2.497A.

Press “V/A”, go to the next screen.

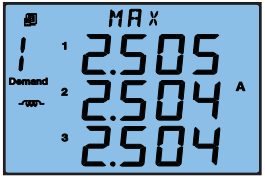


Fig.3-27 Max value of demand current

The 7th screen: display the Max value of current demand.

As in fig 3.27 I1_Demand_Max=2.505A, I2_Demand_Max=2.504A, I3_Demand_Max =2.504A.

Press "V/A" key; go back to the 1st screen.

3.3.2 Display the Max value of power and reactive power demand.

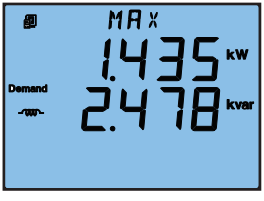


Fig.3-28 Max value of demand power and reactive power

Press "P" key under the statistics display mode, to display the Max value of power and reactive power demand.

As in Fig.3-28 P_Demand_Max= 1.435kW, Q_Demand_Max=2.478kvar.

Note: when the wiring of voltage input is set to 2LL or 3LL, there is no the 1st and 2nd screen.

3.3.3 Display power quality parameter

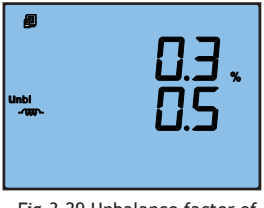


Fig.3-29 Unbalance factor of voltage and current

Press "H" key under the statistics display mode, to display the unbalance factor of voltage and current and harmonic rate of voltage and current.

The 1st screen: display three phase voltage unbalance factor and three phase current unbalance factor.

As in fig.3-29 voltage unbalance factor=0.3%, current unbalance factor=0.5%.

Press “H” key, go to the next screen.

Press “H” key to display harmonic rate of voltage and current. The screen will roll from 2nd harmonic rate of voltage to 15th harmonic rate of current as you press “H” each time. The HARMO label displays on the top of screen. The following screens show the 2nd and 16th screen as example.

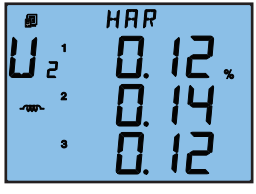


Fig.3-30 2nd harmonic rate of phase voltage

The 2nd screen: display 2nd harmonic rate of voltage.

As in fig.3-30, U1_Hr2=0.12%, U2_Hr2=0.12% , U3_Hr2=0.12%.

Note: when the wiring of voltage input is set to 2LL or 3LL, there is no harmonic rate of phase voltage; the harmonic rate of line to line voltage will be shown as in Fig.3-30.

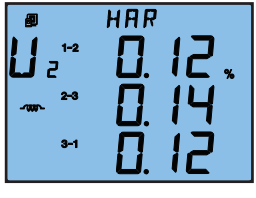


Fig.3-31 2nd harmonic rate of line to line voltage

The 2nd screen: display 2nd harmonic rate of line to line voltage.

As in Fig.3-31, U12_Hr2=0.12%, U23_Hr2=0.14% , U31_Hr2=0.12%.

Press “H” key in turn, display 3rd to 15th voltage harmonic rate, the corresponding screen is 3rd to 15th.

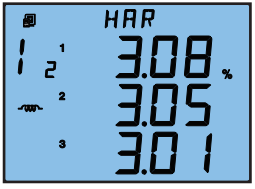


Fig.3-32 2nd harmonic rate of current

The 16th screen: display 2nd harmonic rate of current.

As in Fig.3-32, I1_Hr2=3.08%, I2_Hr2=3.05% , I3_Hr2=3.01%.

Press “H” key in turn, display 3rd to 15th current harmonic rate, the corresponding screen is 17th to 29th.

3.4 System parameter setting of Acuvim-L

Note

The setting should be done by the professional personnel who have read the user’s manual and understood the application situation.

Note

When we press H and V/A keys simultaneously to exit the setting mode, the setting of current page will not be stored.

Under the metering data display mode, press the “H” and “V/A” key simultaneously, get into system parameter setting mode of the meter. All of the settings can be done through the keys on the panel.

Under the meter parameter setting mode, press “H” key to move cursor. Right move one digit each time. Press “P” for increasing and press “E” for decreasing. Press “V/A” for acknowledgment and going to the next setting item page. Press “H” and “V/A” keys simultaneously to exit from any setting item page.

Access code is needed for going into the system parameter setting mode. Only the person who knows the access code can do the parameter setting. The access code is 4 digits decimal number. It is from 0000 to 9999. The factory

default is 0000. After key in the right access code, press "V/A" to go to the first parameter setting page, otherwise go back to the metering data display page.

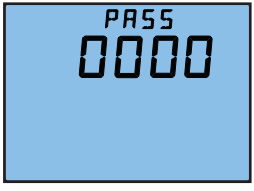


Fig.3-32 Access code page

Fig.3-32 is the access code page.

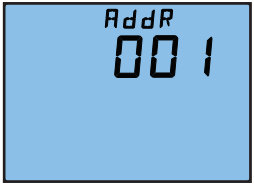


Fig.3-33 Address setting page

The 1st screen: setting Acuvim-L address page for commutation purpose. It is any digit number from 1-247. it's shown as Fig.3-33: the address of Acuvim-L is 1.

Press "H" to move the cursor to the digit that needed to be changed, press "P" for increasing and press "E" for decreasing, press for the acknowle- dgment.

Note: every meter should have different address according to the Modbus-RTU protocol in the same RS-485 net.

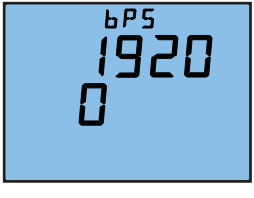


Fig.3-34 Baud rate setting page

The 2nd screen: baud rate setting page.

The asynchronous communication setting of Acuvim-L is 8 bit, no parity, 1 start bit and 1 stop bit. Baud rate can be set as follows: 1200, 2400, 4800, 9600, 19200, 38400. Press P or E to change the baud rate.

Press "V/A", go to the next screen.

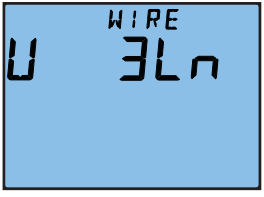


Fig.3-35 Voltage input wiring

The 3rd screen: voltage input wiring setting page. Voltage input could be one of four modes, 3Ln, 2Ln, 2LL and 3LL.

As in Fig.3-35: the voltage input mode is set to 3Ln.

Press “V/A”, go to the next screen.

Fig.3-36 Current input wiring

The 4th screen: current input wiring setting page. Current input could be one of three modes, 3Ct, 1Ct and 2Ct.

As in Fig.3-36: the current input mode is set to 3Ct.

Press “V/A”, go to the next screen.

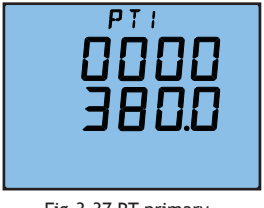


Fig.3-37 PT primary

The 5th screen: PT primary rating voltage PT1 setting page.

The value range of PT1 is from 50.0-1000, 000.0. Unit is volt.

As in Fig.3-37, PT1=380.0V, press “H”, “E” and “P” to change the value. Press “V/A” key for acknowledgement and go to next page.

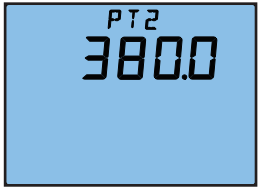


Fig.3-38 PT secondary

The 6th screen: PT secondary rating voltage PT2 setting page.

The value range of PT2 is from 50.0-400.0. Unit is Volt.

As in Fig.3-38, PT2=380.0V, press “H”, “E” and “P” to change the value. Press “V/A” key for acknowledgement and go to next page.

Note: If there is no PT on the voltage input side of Acuvim-L, the PT1 and PT2 should be the same and equal to the input rated voltage.

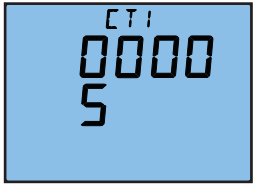


Fig.3-39 CT primary

The 7th screen: CT primary rating current CT1 setting page.

CT1 is an integer from 5-50000. Unit is Amp.

As in Fig.3-39, CT1=5A, press “H”, “E” and “P” to change the value. Press “V/A” key for acknowledgement and go to next page.

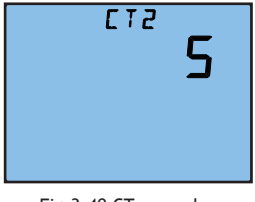


Fig.3-40 CT secondary

The 8th screen: CT secondary rating current CT2 setting page.

CT2 is a constant equal 5. unit is Amp.

If 1A specification needed, it should be ordered.

As in Fig.3-40, CT1=5A, Press “V/A” key, go to next page.

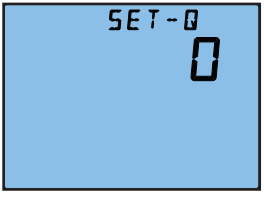


Fig.3-41 Definition of reactive power

The 9th screen: definition setting of reactive power.

0: sinusoidal reactive power;

1: Budeanu's reactive power.

Please refer to << Introduction of measurement and functions of Acuvim-L>> for details.

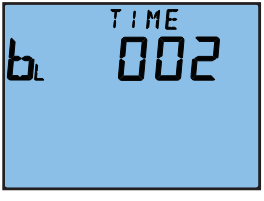


Fig.3-42 Back light "on" time

The 10th screen: back light "on" time setting page.

The "on" time can be set from 0 to 120 Minute. The back light will always be "on" if the setting value is 0. If it is other value, it means after the setting time it will goes off if no key has been pressed. It will be "on" whenever you press any key if it is "off".

As in Fig.3-42, the setting time of back light is 2 minute, namely the back light will go "off" automatically if there is no touch on the keys.

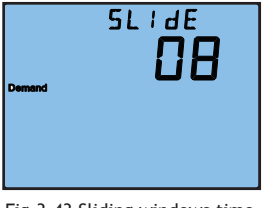


Fig.3-43 Sliding windows time

The 11th screen: sliding windows time of demand setting page.

Sliding windows time of demand is from 1-30 minute. The window slides once per minute.

As in Fig.3-43, the sliding windows time is 8 minute.

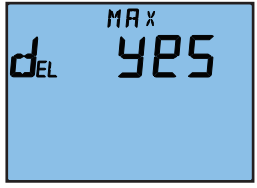


Fig.3-44 Clear Max and Min page

The 12th screen: the setting page of clearing Max and Min.

The Max and Min value of Acuvim-L can be cleared via panel, and then the new data is registered.

Press “P” or “E” to select “yes” or “No”:

No: do not clear Max and Min;

Yes: clear Max and Min.

Press “V/A” key, go to next page.

Fig.3-45 Clear energy enable

The 13th screen: clear energy enable setting page.

The energy of Acuvim-L can be cleared via panel, and then the new data is registered.

1: enable; 0: disable.

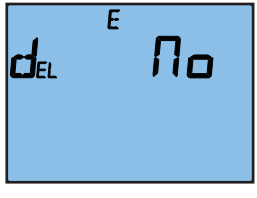


Fig.3-46 Acknowledgement to clear energy

The 14th screen: the setting page of acknowledgement to clear energy.

Press “E” or “P” to select “yes” or “No”:

“Yes”: clear energy;

“No”: do not clear energy.

Press “V/A” key, go to next page.

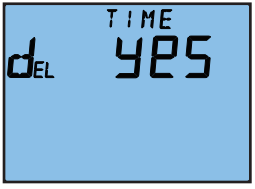


Fig.3-47 Alear running time

The 15th screen: the setting page of clearing running time.

The running time of Acuvim-L can be cleared via panel, and then the new time is registered.

Press “P” or “E” to select “yes” or “No”:

“No”: do not clear running time;

“Yes”: clear running time.

Press “V/A”key, go to next page.

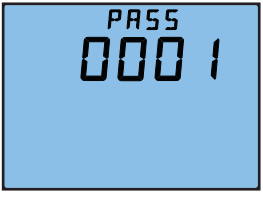


Fig.3-48 Access code setting

The 16th screen: access code setting page.

It is the last screen of system parameter setting page. The access code can be changed in the page. It’s important to remember the new access code.

As in Fig.3-48, the access code is 0001. Press “V/A” key, the access code will be stored in Acuvim-L. Press “H” key and “V/A” key to exit the system setting mode when all the setting has been finished.

3.5 DO parameter setting of Acuvim-L

Acuvim-BL meter has two digital outputs. Each can operate as energy pulse output or alarm output. All parameters about DO can be set via panel. To distinguish with system parameter setting mode, we call the setting mode about DO as DO parameter setting mode.

Press “H” key and “E” key simultaneity under the system parameter setting mode will enter the DO parameter setting mode. The operation of keys is the same as in pre-setting pages. You need to press “P” and “E” simultaneously to exit and back to system parameter setting mode; press “H” and “V/A” simultaneously to exit the system pentameter setting mode and enter the metering data display page.

The following figures show how to set the DO items:

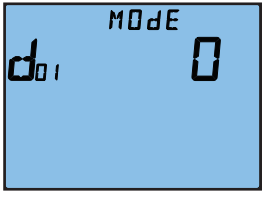


Fig.3-49 DO1 output mode setting

The 1st screen: DO1 output mode setting page.

0: pulse output;

1: alarm output.

As Fig.3-49, DO1 is set as pulse output mode.

Press “V/A” key for acknowledgement and going to next page.

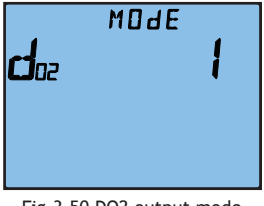


Fig.3-50 DO2 output mode setting

The 2nd screen: DO2 output mode setting page.

0: pulse output;

1: alarm output.

As Fig.3-50, DO2 is set as alarm output mode.

Press “V/A” key for acknowledgement and going to next page.

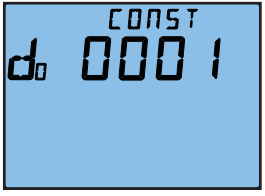


Fig.3-51 DO pulse rate

The 3rd screen: Pulse rate setting page.

Pulse rate means the energy value per pulse. It can be the integer of 1 to 6000. One digit is 0.1kWh or 0.1kVarh.

As Fig.3-51, the pulse rate is 10.

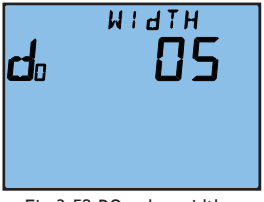


Fig.3-52 DO pulse width

The 4th screen: the DO pulse width setting.

The DO pulse width is integer from 1 to 50. One digit is 20ms.

As in Fig.3-52, the pulse width is set to 5, that is 5×20=100ms.

Press “V/A” key for acknowledgement and going to next page.

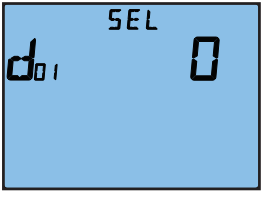


Fig.3-53 DO1 output items

The 5th screen: DO1 output item setting.

The DO1 output can be one of the following energy items shown in table below:

As in Fig.3-53, DO1 has no pulse output.

Item value	0	1	2	3	4
Energy select	No output	Ep_imp	Ep_exp	Eq_imp	Eq_exp

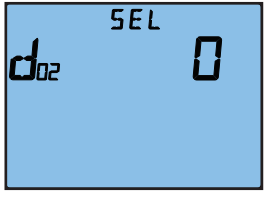


Fig.3-54 DO2 output items

The 6th screen: DO2 output item setting.

The same as DO1 for setting, and they don't effect each other at all.

Press V/A key for acknowledgement and going to next page.

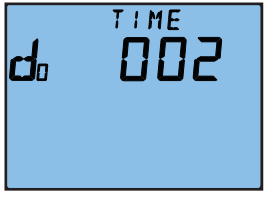


Fig.3-55 DO delay time of alarm setting

The 7th screen: DO delay time of alarm setting page.

When the metering data is over pre-setting limit, how long the alarm output is generated.

The delay time can be an integer from 0-255. One digit is 300ms.

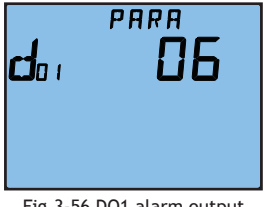


Fig.3-56 DO1 alarm output items

The 8th screen: DO1 alarm output items setting.

The DO1 alarm output can be one of the following energy items shown in table below:

Var	0	1	2	3	4	5	6	7
item	Hz	V1	V2	V3	V12	V23	V31	I1
Var	8	9	10	11	12	13	14	15
item	I2	I3	In	P1	P2	P3	Psum	Q1
Var	16	17	18	19	20	21	22	23
item	Q2	Q3	Qsum	Ssum	PF1	PF2	PF3	PFsum
Var	24	25	26	27	28	29	30	
item	U_unbl	I_unbl	Dmd_P	Dmd_Q	Dmd_I1	Dmd_I2	Dmd_I3	

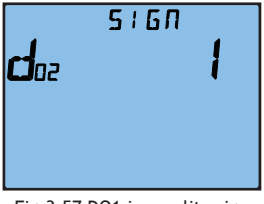


Fig.3-57 DO1 inequality sign

The 9th screen: DO1 inequality sign setting page.

0: <; 1: >.

As in Fig.3-57, the inequality sign is set to 1, that is when the metering data is over the pre-setting limit, an alarm output is generated.

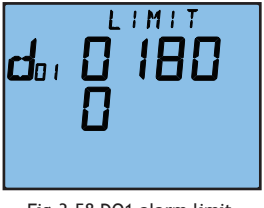


Fig.3-58 DO1 alarm limit

The 10th screen: the setting page of DO1 alarm limit.

Setting steps refer to content of digital output.

As in Fig.3-58, the DO1 limit is set to 1800.

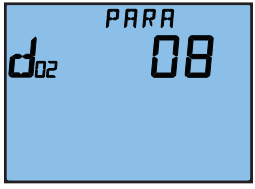


Fig.3-59 DO2 alarm output items

The 11th screen: DO2 alarm output items setting.

The same is as DO1 for setting.

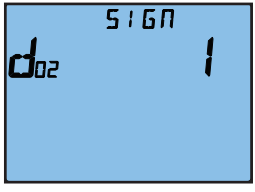


Fig.3-60 DO2 inequality sign

The 12th screen: DO2 inequality sign setting page.

0: <;

1: >.

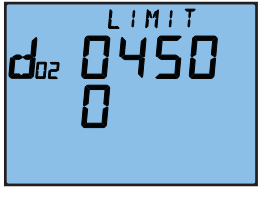


Fig.3-61 DO2 alarm limit

The 10th screen: the setting page of DO2 alarm limit.

Setting steps refer to content of digital output.

As in Fig.3-61, the DO2 limit is set to 4500.

This is the last screen of DO parameter setting. Press “V/A” key for acknowledgement and go to the first screen.

Press “P” key and “E” key simultaneity to exit the setting mode of DO Parameter and enter the setting mode of system parameter.

Press “H” key and “V/A” key simultaneity to exit the setting mode of system Parameter and enter the metering data display page.

3.6 Introduction of measurement and functions of Acuvim-L

Almost all the electric parameters in power systems can be measured by Acuvim-L. Some parameters that the users are not familiar will be introduced in the part.

Voltage (U): True RMS value of three phase voltages, three line to line voltages are measured and displayed in Acuvim-L.

Current (I): True RMS value of three phase current, neutral current are measured and displayed in Acuvim-L.

Power (P): Three phase power and system total power are measured and displayed in Acuvim-L.

Reactive power (Q): Acuvim-L adopts two definitions of reactive power.

1. Sinusoidal reactive power. The formula is as following:

$$Q^2 + D^2 = S^2 - P^2$$

2. Nonsinusoidal reactive power. The formula is as following:

$$Q' = \sqrt{Q^2 + D^2}$$

Where Q_D: Budeanu’s distortion power.

Q: Budeanu’s reactive power.

Apparent power (S): System total apparent power is measured and displayed in Acuvim-L.

Power factor (PF): Three phase power factor and system total power factor are measured and displayed in Acuvim-L.

Frequency (F): The frequency of V1 phase voltage input is measured as system frequency.

Energy (kWh): Energy is time integral of power. The unit is kWh. As power has direction, positive means consumption and negative means generating. So the energy also has the nature of consumption or generating.

Import energy (imp): consumption energy.

Export energy (exp): generating energy.

Reactive energy (kVarh): reactive energy is time integral of reactive power. The unit is kVarh. As reactive power has direction, positive means inductive and negative means capacitive. So the energy also has the nature of inductive or capacitive.

Import energy (imp): inductive energy.

Export energy (exp): capacitive energy.

Harmonic parameter:

Total harmonic distortion: this factor is often used to express the power quality of the power system. The formula is as following:

$$THD = \sqrt{\sum_{h=2}^{\infty}\left(\frac{U_h}{U_1}\right)^2} \times 100\%$$

In the formula, U_1 is Rms value of the voltage fundamental and U_h is Rms value of the voltage harmonic with order n.

Each harmonic rate: the percentage of each harmonic divided by fundamental.

$$HRU_h = \frac{U_h}{U_1} \times 100\% \qquad HRI_h = \frac{I_h}{I_1} \times 100\%$$

Demand: demand of total power and reactive power of system, demand of three phase current. The demand statistics method in

Acuvim-L is sliding windows. The sliding window time can be chose from 1 to 30 minute. The window slides one minute each time. For example, the sliding window time is supposed to be three minutes. If average power of the 1st minute is 12, that of the 2nd minute is 14 and that of the 3rd minute is 10, then the total power demand the last three minute is (12+14+10)/3=12 at the end of the 3rd minute. If another minute passed, the average power of the minute is 9, then the total power demand of the last three minute is (14+10+9)/3=11 at the end of the 4th minute.

Unbalance factor: Acuvim-L can measure the unbalance factor of three –phase voltage and current using method of sequence vector.

Max/Min: Acuvim-L can measure the max value of system total power, reactive power and apparent power and the max/min of the three phase voltage and current. The value of metering data is stored in NV-RAM and can be accessed or cleared via control panel or communication.

Over limit alarming: In Acuvim-BL, when the metering data is over the pre-setting limit and over presetting time interval, the over limit alarming will be picked up. The digital output (DO) can be used as trigger to light or sound alarming. An example is given following to describes how the over limit alarming work.

For example:

When current Ib goes over 180A and duration is over 15 seconds, an over limit alarming will be generated (Suppose that the Ct ratio is 200), and output via DO1, the setting steps is as following:

1) firstly, set the mode of DO1 as alarming output, namely the value of DO1 mode is set to 1;

2) secondly, delay time is 15 seconds, for the basic unit of delay time is 300ms, the setting value of delay time is 15÷0.3＝50.

3) Thirdly, alarm parameter is Ib, the value of alarm parameter is set to 8.

4) Ib is greater than 180A, so the alarm inequality sign is set to 1.

5) The setting value of alarm limit is calculated as the following equation:

Real value = (setting value×Ct1÷Ct2) ÷1000

So the setting value of alarm limit is 4500.

Then we have completed the setting of over limit alarming.

Energy pulse output: The two digital outputs of Acuvim-BL can be used as energy pulse output. The output energy can be selected among all kinds of energy and reactive energy. Pulse constant and pulse width can be set to meet your requirements. Pulse constant is the kWh a pulse stands for; pulse width is the time that a pulse lasts. When the accumulated energy reaches the pulse constant, there will be a pulse on DO.

Related parameters: pulse energy output ranges from 0 to 4 corresponding to none, Ep_imp, Ep_exp, Eq_imp, Eq_exp.

Pulse constant ranges from 1 to 6000 (integer) with a unit of 0.1kWh (kvarh), apparently that is the resolving power of energy output.

Pulse width ranges from 1 to 50 (integer) with a unit of 20ms. The narrowest interval between two pulses is 20ms.

In practice the pulse width and the pulse ratio are selected according to system power. The relation of the two parameters should satisfied following expression:

pulse ratio >[(pulse width +1)×Pmax]÷18000

In the expression, the Pmax is the maximum power or reactive power. The unit is kW or kvar. Recommend pulse ratio is 3 to 5 times the right side value of the above expression.

Chapter 4 Communication

Introducing Modbus Protocol

Format of Communication

Data Address Table

This chapter will mainly discuss how to operate the meter via communication port using software. To master this chapter, you should be familiar with Modbus and read other chapters of this manual to make sure that you have generously mastered the function and application of this product.

This chapter includes: Modbus protocol, format of communication and data address table and Acuvim-L application details.

4.1 Introducing Modbus protocol

The Modbus RTU protocol is used for communication in Acuvim-L. The data format and error check methods are defined in Modbus protocol. The half duplex query and respond mode is adopted in Modbus protocol. There is only one master device in the communication net. The others are slave devices, waiting for the query of the master.

Transmission mode

The mode of transmission defines the data structure within a frame and the rules used to transmit data. The mode is defined in the following which is compatible with Modbus RTU Mode*.

* Modbus is trademark of Modicon, Inc.

Coding system	8-bit binary
Start bit	1
Data bits	8
Parity	No parity
Stop bit	1
Error checking	CRC check

4.2 Modbus Protocol

Framing

Address	Function	Data	Check
8-bit	8-bit	N×8-bit	16-bit

Table 4-1 data frame format

Address field

The address field of a message frame contains eight bits. Valid slave device addresses are in the range of 0~247 decimal. A master addresses a slave by placing the slave address in the address field of the message. When the slave sends its response, it places its own address in this address field of the response to let the master know which slave is responding.

Function field

The function code field of a message frame contains eight bits. Valid codes are in the range of 1~255 decimal. When a message is sent from a master to a slave device the function code field tells the slave what kind of action to perform.

Code	Meaning	Action
03	Read data	Obtain current binary value in one or more registers
16	Preset multiple-registers	Place specific value into a series of consecutive multiple-registers

Table 4-2 Function code

Data field

The data field is constructed using sets of two hexadecimal digits, in the range of 00 to FF hexadecimal. The data field of messages sent from a master to slave devices contains additional information which the slave must use to take the action defined by the function code. This can include items like discrete and register addresses, the quantity of items to be handled, and the count of actual data bytes in the field. For example, if the master requests a slave to read a group of holding registers (function code 03), the data field specifies the starting register and how many registers are to be read. If the master writes to a group of registers in the slave (function code 10 hexadecimal), the data field specifies the starting register, how many registers to write, the count of data bytes to follow in the data field, and the data to be written into the registers.

If no error occurs, the data field of a response from a slave to a master contains the data requested. If an error occurs, the field contains an exception code that the master application can use to determine the next action to be taken. The data field can be nonexistent (of zero length) in certain kinds of messages.6.

Error Check Field

Messages include an error-checking field that is based on a Cyclical Redundancy Check (CRC) method. The CRC field checks the contents of the entire message. It is applied regardless of any parity check method used for the individual characters of the message. The CRC field is two bytes, containing a 16 bit binary value. The CRC value is calculated by the transmitting device, which appends the CRC to the message.

The receiving device recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it

received in the CRC field. An error results if the two values are not equal. The CRC is started by first preloading a 16-bit register to all 1's. Then a process begins of applying successive 8-bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits, and the parity bit, do not apply to the CRC.

During generation of the CRC, each 8-bit character is exclusive ORed with the register contents. Then the result is shifted in the direction of the least significant bit (LSB), with a zero filled into the most significant bit (MSB) position. The LSB is extracted and examined. If the LSB was a1, the register is then exclusive ORed with a preset, fixed value. If the LSB was a 0, no exclusive OR takes place. This process is repeated until eight shifts have been performed. After the last (eighth) shift, the next 8-bit byte is exclusive ORed with the register current value, and the process repeats for eight more shifts as described above. The final contents of the register, after all the bytes of the message have been applied, is the CRC value. When the CRC is appended to the message, the low-order byte is appended first, followed by the high-order byte.

4.3 Format of communication

Explanation of frame

Addr	Fun	Data start reg hi	Data start reg lo	Data #of regs hi	Data #of regs lo	CRC16 Hi	CRC16 Lo
06H	03H	00H	00H	00H	21H	84H	65H

Table 4-3 Explanation of a frame

As shown in table 4-3 the meaning of each abbreviated word is:
Addr: address of slave device

Fun: function code
Data start reg hi: start register address high byte
Data start reg lo: start register address low byte
Data #of reg hi: number of register high byte
Data #of reg lo: number of register low byte
CRC16 Hi: CRC high byte
CRC16 Lo: CRC low byte

1. Read Data (Function Code 03)

Query

This function allows the master to obtain the measurement results of Acuvim-L. Table 4-4 is an example to read the 3 measured data (F, V1 and V2) from slave device number 17, the data address of F is 0130H, V1 is 0131H and V2 is 0132H.

Addr	Fun	Data start addr hi	Data start Addr Lo	Data #of Regs hi	Data #of Regs lo	CRC16 hi	CRC16 lo
11H	03H	01H	30H	00H	03H	06H	A8H

Table 4-4 Read F, V1 and V2 Query Message

Response

The Acuvim-L response includes the address code, function code, quantity of data byte, data, and error checking. An example response to read F, V1 and V2 (F=1388H (50.00Hz), V1=03E7H (99.9V), V2=03E9H (100.1V) is shown as Table4.9.

Addr	Fun	Byte count	Data1 hi	Data1 Lo	Data 2 hi	Data2 lo	Data3 hi	Data3 Lo	CRC16 hi	CRC16 lo
11H	03H	06H	13H	88H	03H	E7H	03H	E9H	7FH	04H

Table 4-5 Read F, V1 and V2 Message of response

2. Preset / Reset Multi-Register (Function Code 16)

Query

Function 16 allows the user to modify the contents of a Multi-Register. Any Register that exists within the Acuvim-L can have its contents changed by this message. The example below is a request to an Acuvim-L number 17 to Preset Ep_imp = (17807783.3KWH), while its Hex Value 0A9D4089H. Ep_imp data address is 0156H and 0157H.

Addr	Fun	Data start reg hi	Data start reg lo	Data #of reg hi	Data #of reg lo	Byte Count
11H	10H	01H	56H	00H	02H	04H

Value Hi	Value Lo	Value Hi	Value lo	CRC hi	CRC Lo
0AH	9DH	40H	89H	4DH	B9H

Table 4-6 Preset KWH Query Message

Response

The normal response to a preset Multi-Register request includes the Acuvim-L address, function code, data start register, the number of registers, and error checking.

Addr	Fun	Data start reg hi	Data start reg lo	Data #of reg hi	Data #of Reg lo	CRC16 hi	CRC16 lo
11H	10H	01H	0CH	00H	02H	A2H	B4H

Table 4-7 Preset Multi-Registers Message of Response

4.4 Data address table of Acuvim-L

Basis measurements

The data address of basis measurements includes primary data address and secondary data address. Function code: 03 read.

Address	Parameter	Range	Data type	Type of access
0130H	Frequency F	0～65535	word	R
0131H	phase voltage V1	0～65535	word	R
0132H	phase voltage V2	0～65535	word	R
0133H	phase voltage V3	0～65535	word	R
0134H	Line voltage V12	0～65535	word	R
0135H	Line voltage V23	0～65535	word	R
0136H	Line voltage V31	0～65535	word	R
0137H	Phase(line)current I1	0～65535	word	R
0138H	Phase(line)current I2	0～65535	word	R
0139H	Phase(line)current I3	0～65535	word	R
013AH	Neutral line current In	0～65535	word	R
013BH	Phase power Pa	-32768～32767	Integer	R
013CH	Phase power Pb	-32768～32767	Integer	R
013DH	Phase power Pc	-32768～32767	Integer	R
013EH	System power Pcon	-32768～32767	Integer	R
013FH	Phase reactive power Qa	-32768～32767	Integer	R
0140H	Phase reactive power Qa	-32768～32767	Integer	R
0141H	Phase reactive power Qb	-32768～32767	Integer	R
0142H	System reactive power Qcon	-32768～32767	Integer	R
0143H	System Apparent power Scon	0～65535	word	R
0144H	Phase power factor PFa	-1000～1000	Integer	R
0145H	Phase power factor PFb	-1000～1000	Integer	R
0146H	Phase power factor PFc	-1000～1000	Integer	R
0147H	System power factor PFcon	-1000～1000	Integer	R
0148H	Voltage unbalance factor U_unbl	0～1000	word	R
0149H	Current unbalance factor I_unbl	0～1000	word	R
014AH	Load nature RT（L/C/R）	76/67/82	word	R
014BH	reserved	---	---	---
014CH	reserved	---	---	---

014DH	reserved	---	---	---
014EH	reserved	---	---	---
014FH	reserved	---	---	---
0150H	power demand P_DEMA	-32768~32767	Integer	R
0151H	reactive power demand Q_DEMA	-32768~32767	Integer	R
0152H	Phase A current demand Ia_DEMA	0~65535	word	R
0153H	Phase B current demand Ib_DEMA	0~65535	word	R
0154H	Phase C current demand Ic_DEMA	0~65535	word	R
0155H	reserved	---	---	---

Table 4-8 data address of basic measurements

The relationship between numerical value in register of Acuvim-L and the real physical value is as following table. (Rx is numerical value in register of Acuvim-L)

Parameter	Relationship	Unit
Voltage V1,V2,V3,V12,V23,V31	U=Rx × (PT1 / PT2) /10	Volt(V)
Current I1,I2,I3, In	I=Rx ×(CT1/CT2) /1000	Amp（A）
Power Pa, Pb, Pc, Psum	P=Rx × (PT1 / PT2) × (CT1/ CT2)	Watt（W）
Reactive power Qa, Qb, Qc, Qsum	Q=Rx × (PT1 / PT2) × (CT1/ CT2)	Var
Apparent power Ssum	S=Rx × (PT1 / PT2) × (CT1/ CT2)	VA
Power factor PFa, PFb, PFc, PFsum	PF=Rx / 1000	NA
Frequency	F=Rx / 100	Hz
Load nature（R/L/C）	76/67/82	NA
Voltage or current unbalance factor U_unbl, I_unbl	Unbl=(Rx/1000)×100%	NA

Table 4-9 Conversion relationship of basic measurements

Address	Parameter	Data type	Data of access
0600H-0601H	Frequency F	Float	R
0602H-0603H	Phase voltage V1	Float	R
0604H-0605H	Phase voltage V2	Float	R
0606H-0607H	Phase voltage V3	Float	R
0608H-0609H	Line voltage V12	Float	R
060AH-060BH	Line voltage V23	Float	R
060CH-060DH	Line voltage V31	Float	R
060EH-060FH	Phase (line) current I1	Float	R
0610H-0611H	Phase (line) current I2	Float	R
0612H-0613H	Phase (line) current I3	Float	R
0614H-0615H	Neutral line current In	Float	R
0616H-0617H	Phase power Pa	Float	R
0618H-0619H	Phase power Pb	Float	R
061AH-061BH	Phase power Pc	Float	R
061CH-061DH	System power Pcon	Float	R
061EH-061FH	Phase reactive power Qa	Float	R
0620H-0621H	Phase reactive power Qb	Float	R
0622H-0623H	Phase reactive power Qc	Float	R
0624H-0625H	System reactive power Qcon	Float	R
0626H-0627H	System apparent Scon	Float	R
0628H-0629H	Phase power factor PFa	Float	R
062AH-062BH	Phase power factor PFb	Float	R
062CH-062DH	Phase power factor PFc	Float	R
062EH-062FH	System power PFcon	Float	R
0630H-0631H	Voltage unbalance factor U_unbl	Float	R
0632H-0633H	Current unbalance factor I_unbl	Float	R
0634H-0635H	Reserved		

0636H~0637H	Reserved		
0638H~0639H	Reserved		
063AH~063BH	Reserved		
063CH~063DH	Reserved		
063EH~063FH	Reserved		
0640H~0641H	power demand P_DEMA	Float	R
0642H~0643H	reactive power demand Q_DEMA	Float	R
0644H~0645H	Phase A current demand Ia_DEMA	Float	R
0646H~0647H	Phase B current demand Ib_DEMA	Float	R
0648H~0649H	Phase C current demand Ic_DEMA	Float	R
064AH~064BH	Reserved		

Table 4-10 primary data address of basic measurements

Energy measurements

Function code: 03 read; 16 Pre-set

Address	Parameter	Range	Data type	Type of access
0156H（High 16 bit）	Import Energy Ep_imp	0-99999999.9	DWord	R/W
0157H（Low 16 bit）				
0158H（High 16 bit）	Export Energy Ep_exp	0-99999999.9	DWord	R/W
0159H（Low 16 bit）				
015AH（High 16 bit）	Import reactive energy Eq_imp	0-99999999.9	DWord	R/W
015BH（Low 16 bit）				
015CH（High 16 bit）	Export reactive energy Eq_imp	0-99999999.9	DWord	R/W
015DH（Low 16 bit）				

Table 4-11 Data address of energy measurements

The relationship between numerical value in register of Acuvim-L and the real physical value is as following table. (Rx is numerical value in register of Acuvim-L).

Parameter	Relationship	Unit
Energy Ep_imp, Ep_exp	Ep=Rx/10	kWh
Reactive energy Eq_imp, Eq_exp	Eq=Rx/10	kvarh

Table 4-12 Conversion relationship of Energy dada

Power quality measurements

Function code: 03 read

Address	Parameter	Range	Data type	Type of access
0400H	Total harmonic distortion of V1 or V12 THD_V1	0～10000	word	R
0401H	Total harmonic distortion of V2 or V23 THD_V2	0～10000	word	R
0402H	Total harmonic distortion of V3 or V31 THD_V3	0～10000	word	R
0403H	Total harmonic distortion of I1 THD_ I1	0～10000	word	R
0404H	Total harmonic distortion of I2 THD_ I2	0～10000	word	R
0405H	Total harmonic distortion of I3 THD_ I3	0～10000	word	R
0406H-0413H	Harmonic content of V1 or V12 （2nd ~15th ）	0～10000	word	R
0414H-0421H	Harmonic content of V2 or V23 （2nd ~15th ）	0～10000	word	R
0422H-042FH	Harmonic content of V3 or V31 （2nd ~15th ）	0～10000	word	R
0430H-043DH	Harmonic content of I1 （2nd ~15th ）	0～10000	word	R
043EH-044BH	Harmonic content of I2 （2nd ~15th ）	0～10000	word	R
044CH-0459H	Harmonic content of I3 （2nd ~15th ）	0～10000	word	R

Table 4-13 Data table of Power quality measurements

The relationship between numerical value in register of Acuvim-L and the real physical value is as following table. (Rx is numerical value in register of Acuvim-L)

Parameter	Relationship	Unit
THD	THD=Rx/10000×100%	NA
Harmonic content	THDn=Rx/10000×100%	NA

Table 4-14 Conversion relationship of Power quality measurements

Statistics measurements

The data address of Statistics measurements includes primary data address and secondary data address. Function code: 03 read

Address	Parameter	Range	Data type	Type of access
0460H	Max of V1 V1_max	0~65535	word	R
0461H	Max of V2 V2_max	0~65535	word	R
0462H	Max of V3 V3_max	0~65535	word	R
0463H	Max of V12 V12_max	0~65535	word	R
0464H	Max of V23 V23_max	0~65535	word	R
0465H	Max of V31 V31_max	0~65535	word	R
0466H	Max of I1 I1_max	0~65535	word	R
0467H	Max of I2 I2_max	0~65535	word	R
0468H	Max of I3 I3_max	0~65535	word	R
0469H	Max of power demand PDmd_max	-32768~32767	integer	R
046AH	Max of reactive power demand QDmd_max	-32768~32767	integer	R
046BH	Max of current demand Ia IaDEMA_max	0~65535	word	R
046CH	Max of current demand Ib IbDEMA_max	0~65535	word	R
046DH	Max of current demand Ic IcDEMA_max	0~65535	word	R

046EH	reserved	---	---	---
046FH	reserved	---	---	---
0470H	Min of V1 V1_min	0~65535	word	R
0471H	Min of V2 V2_min	0~65535	word	R
0472H	Min of V3 V3_min	0~65535	word	R
0473H	Min of V12 V12_min	0~65535	word	R
0474H	Min of V23 V23_min	0~65535	word	R
0475H	Min of V31 V31_min	0~65535	word	R
0476H	Min of I1 I1_min	0~65535	word	R
0477H	Min of I2 I2_min	0~65535	word	R
0478H	Min of I3 I3_min	0~65535	word	R
0479H	reserved	---	---	---
047AH	reserved	---	---	---
047BH	reserved	---	---	---
047CH	Run time (High 16 bit)	0~99999999.9	DWord	R
047DH	Run time (Low 16 bit)			

Table 4-15 Secondary data address of Statistics measurements

The relationship between numerical value in register of Acuvim-L and the real physical value is as following table. (Rx is numerical value in register of Acuvim-L)

The data formant of statistics measurements is the same as that of Basis measurements except for run time of meter; the conversion relationship refers to Table 4-8.

The table below is the conversion relationship for run time.

Parameter	relationship	Unit
Run time of meter	Run_Hour＝Rx/10	Hour

Table 4-16 Conversion relationship of run time

Address	Parameter	Data type	Data of access
064CH~064DH	Max of V1 V1_max	Float	R
064EH~064FH	Max of V2 V2_max	Float	R
0650H~0651H	Max of V3 V3_max	Float	
0652H~0653H	Max of V12 V12_max	Float	R
0654H~0655H	Max of V23 V23_max	Float	R
0656H~0657H	Max of V31 V31_max	Float	R
0658H~0659H	Max of I1 I1_max	Float	R
065AH~065BH	Max of I2 I2_max	Float	R
065CH~065DH	Max of I3 I3_max	Float	R
065EH~065FH	Max of power demand PDmd_max	Float	R
0660H~0661H	Max of reactive power demand QDmd_max	Float	R
0662H~0663H	Max of current demand Ia IaDEMA_max	Float	R
0664H~0665H	Max of current demand Ib IbDEMA_max	Float	R
0366H~0667H	Max of current demand Ic IcDEMA_max	Float	R
0368H~0669H	Reserved		
036AH~066BH	Reserved		
066CH~066DH	Min of V1 V1_min	Float	R
066EH~066FH	Min of V2 V2_min	Float	R
0670H~0671H	Min of V3 V3_min	Float	R
0672H~0673H	Min of V12 V12_min	Float	R
0674H~0675H	Min of V23 V23_min	Float	R
0676H~0677H	Min of V31 V31_min	Float	R
0678H~0679H	Min of I1 I1_min	Float	R
067AH~067BH	Min of I2 I2_min	Float	R
067CH~067DH	Min of I3 I3_min	Float	R
067EH~067FH	Reserved		

0680H~0681H	Reserved		
0682H~0683H	Reserved		

Table 4-17 primary data address of Statistics measurements

Parameter setting

Function code: 03 read; 16 preset

Address	Parameter	Data type	Range	Type of access
0100H	Access code	word	0~9999	R/W
0101H	Communication address	word	0~247	R/W
0102H	Baud rate	word	1200-38400	R/W
0103H	Voltage input wiring type	word	0:3Ln;1:2ln;2:2LL;3:3LL	R/W
0104H	Current input wiring type	word	0:3CT;1:1CT;2:2CT	R/W
0105H	PT1(High 16 bit)	DWord	50.0~1000000.0	R/W
0106H	PT1(Low 16 bit)			
0107H	PT2	Word	50.0~400.0	R/W
0108H	CT1	Word	1~50000	R/W
0109H	CT2	Word	5	R/W
010AH	Definition of reactive power	word	0: Sinusoidal; 1: Nonsinusoidal	R/W
010BH	“On” time of back light	word	0~120	R/W
010CH	Time of Demand slid window	word	1~30	R/W
010DH	Clear Max	Word	0aH: clear	R/W
010EH	Clear energy enable	Word	0:disable；1：enable	R/W
010FH	Clear energy	Word	0: do not clear; 0aH: clear	R/W
0110H	Clear run time	Word	0aH: clear	R/W

Table 4-18 Data address of setting parameter

Note:

1. data type:

Word: unsigned integer of 16 bit;
Integer: signed integer of 16 bit;
DWord: unsigned integer of 32 bit;
Float: float data of 32 bit.

2. type of access

R: read only, data read by using function code 03.

R/W: read and write, data read by using function 03 and written by using function code 16.

It is forbidden to write data address which dose not possesses property to be written.

3. Energy and run time

Energy and run time data is represented in 32 bit. Both high 16 bit and low 16 bit have successive address alone. The high 16 bit should be multiplied by 65535 and plus low 16 bit data to get the energy and run time data in master software. The unit is 0.1kWh, 0.1kVarh and 0.1hour. The energy register can be cleared or preset via communication. The register of run time can be cleared and can not be preset.

Appendix

Appendix A Technical data and specifications

Appendix B Ordering Information

Appendix C Revision History

Appendix A Technical data and Specification

Input ratings

Voltage input	
Voltage rating	400 LN / 690 LL Vac RMS (3-phase), 400 LN Vac RMS（single-phase） With 20% overage (3LN or 2LN wiring) Installation Category III, Pollution Degree 2
Frequency range	45~65Hz
overload	2 times(continuously); 2500Vac per second (no recurrence)
Voltage range through PT	1000KV highest at primary side
PT burden	<0.2VA
Measuring	True-Rms

Current input	
Current rating	5Amp AC (1Amp AC Optional)
Current range	50000A highest at primary side
Overload	10A (continuously); 100A per sec(no recurrence)
CT burden	<0.5VA
Measuring	True-Rms

Accuracy

Parameter	Accuracy
Voltage	0.5%
Current	0.5%
Current demand	0.5%
Power	1.0%
Reactive power	1.0%
Apparent power	1.0%
Power demand	1.0%
Reactive power demand	1.0%
Power factor	1.0%
Frequency	0.5%
Energy	1.0%
Reactive energy	1.0%
Unbalance factor	1.0%
Harmonic	2.0%
Drift with temperature	<100ppm/℃
Stability	0.1%/year

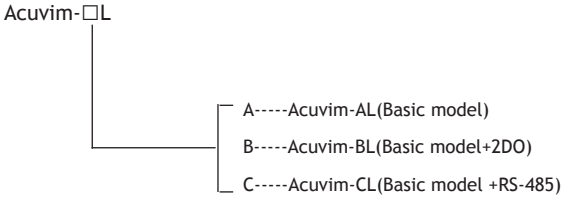
Standards	
measuring	IEC 61036 Class1, ANSI C12.16 Class10
Environmental	IEC60068-2
Safety	IEC61010-1, UL61010-1
EMC	IEC61000-4/2-3-4-5-6-8-11
Dimension	DIN43700/ANSI C39.1

Digital output (DO)	
Output form	Photo-MOS,Form A
Max voltage	250Vac/300Vdc
Max current	50mA
Optical isolation	2500 Vac Rms

Communication port	
Type	RS485, 2 wire, half duplex, optical isolated
Protocol	Modbus-RTU
Baud rate	1200~38400 bps

Suitable condition	
Dimensions (mm)	96×96×51 (cutting-out 92×92 or 4inch Round)
Protection level	IP52 (front), IP30 (cover)
Weight	350g
Operating Temp. range	-25℃ ~ 70℃
Storage temp. range	-40℃ ~ 85℃
Humidity	0~95%, non condensation
Power supply	100~415Vac , 50/60Hz; 100~300Vdc
Power consumption	3W

Appendix B Ordering Information



Note: 1. 5A of the current input is the standard product. Please contact factory if 1A current needed.

2. The range of power supply:
   100~415Vac, 50/60Hz
   100~300Vdc
   Please contact factory if low DC voltage power supply needed.

Appendix C Revision History

Revision	Date	Description
1.0	20070915	
1.1	20070930	Add primary data address table of basic measurements data and Statistics measurements data.

Your Power and Automation Partner

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